

SOLAR OBSERVATIONS

SOLAR RADIATION OBSERVATIONS DURING
NOVEMBER 1936By IRVING F. HAND, *Assistant in Solar Radiation Investigations*

For a description of instruments employed and their exposures, the reader is referred to the January 1935 REVIEW, page 24.

Table 1 shows that solar radiation intensities averaged below normal for November at Washington and Madison, and close to normal at Lincoln. The effect of city smoke and haze as a depletor of solar radiation is markedly shown by observations taken at Lincoln on the 20th. In the afternoon at air mass 2, the value was but slightly below normal; and less than an hour later, or at air mass 3, the value was less than 50 percent of the normal for that air mass. Between the times of taking these two observations, the wind had shifted, bringing city smoke and haze over the station. As smoke and haze diminish the amount of short wave-length radiation, or the so-called health-giving radiation, received at the earth's surface, much more than they do the longer wave lengths, it is reasonable to conclude that under such extreme conditions the amount of ultra-violet reaching the earth is tremendously reduced. As a further example, the radiation receipt at air mass 4 was 23 percent greater than at air mass 3.5 owing to a temporary clearing of the atmosphere. Somewhat similar conditions prevailed in the late afternoon of the same day at Madison.

Table 2 shows a deficiency in the total solar and sky radiation received on a horizontal surface at Washington, Miami, Fairbanks, and Riverside, and an excess at all other stations.

Polarization observations taken at Washington on 71 days give a mean of 55 percent with a maximum of 58 percent on the 14th. At Madison, observations made on 7 days give a mean of 60 percent with a maximum of 71 percent on the 4th. All of these values are below the corresponding normals for the month.

TABLE 1.—*Solar radiation intensities during November 1936*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance										Local mean solar time	
	8 a. m.	73.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°		Noon
	75th mer. time	Air mass										
		A. M.					P. M.					
		e	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0		5.0
	Nov. 9.....	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.		cal.
Nov. 10.....	5.56	0.45	0.61	0.80	0.98	-----	-----	-----	-----	-----	6.27	
Nov. 11.....	8.48	.52	.70	.85	1.02	1.19	-----	-----	-----	-----	5.56	
Nov. 11.....	11.38	-----	-----	1.02	1.19	-----	-----	-----	-----	-----	4.75	

¹ Extrapolated.TABLE 1.—*Solar radiation intensities during November 1936—Con.*

WASHINGTON, D. C.—Continued

Date	Sun's zenith distance											Noon	
	8 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°			
	75th mer. time	Air mass											Local mean solar time
		A. M.						P. M.					
		e	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0		
Nov. 13.	mm	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm		
Nov. 14.	14. 10	-----	-----	-----	94	-----	-----	-----	-----	-----	5. 36		
Nov. 19.	6. 78	-----	-----	83	1. 23	-----	-----	-----	-----	-----	5. 79		
Nov. 23.	5. 56	-----	-----	-----	1. 45	-----	1. 39	1. 23	-----	-----	3. 45		
Nov. 27.	3. 00	-----	-----	-----	1. 12	-----	1. 09	-----	-----	-----	2. 36		
Nov. 27.	4. 37	-----	-----	72	-----	-----	-----	-----	-----	-----	1. 45		
Means.....	(. 48)	(. 66)	. 84	1. 15	-----	-----	1. 16	(1. 23)	-----	-----	-----		
Departures.....	-. 27	-. 21	-. 17	-. 04	-----	-----	-. 02	+. 23	-----	-----	-----		

MADISON, WIS.

Nov. 4.....	2.36		0.94		1.47							1.78
Nov. 10.....	2.74		.92	1.11	1.35				1.10			3.30
Nov. 12.....	4.95							1.36	.99			4.95
Nov. 14.....	5.16				1.43							5.36
Nov. 16.....	2.26	1.04	1.12	1.31	1.43			1.35	1.06			2.62
Nov. 17.....	3.63	.84	.94	1.06	1.33				1.29			4.95
Nov. 20.....	4.57		.80						.93	0.40	0.24	5.16
Nov. 30.....	1.32	.75	.84	1.06								2.26
Means.....	.85	.93	1.14	1.40			(1.37)	1.07	(.40)	(.24)		
Departures.....	-.09	-.08	-.10	-.10			+.04	-.05	-.44			

LINCOLN, NEBR.

Nov. 3.....	1.27	1.09	1.18	1.35	1.51		1.51	1.31	1.18	1.08	1.78
Nov. 5.....	2.74	.96	1.06					1.24	1.07	.97	3.00
Nov. 9.....	3.30	.98	1.14	1.28	1.41					1.04	3.45
Nov. 10.....	3.15	1.00	1.08	1.24	1.44		1.41	1.21	1.06	.96	3.45
Nov. 11.....	3.45	.86	.99	1.16							3.45
Nov. 12.....	3.15							1.20	1.06	.95	4.17
Nov. 13.....	3.15		1.04	1.24							2.57
Nov. 17.....	4.37	.95	1.12	1.26	1.39		1.39	1.20	1.05	.96	4.95
Nov. 19.....	4.95				1.34		1.37				4.95
Nov. 20.....	3.63	.88		1.13	1.35		1.16	.58	.54	.38	4.57
Nov. 21.....	2.49	.97	1.11	1.26	1.48						2.16
Nov. 25.....	1.88	1.20									2.36
Nov. 27.....	2.57							1.11	.97	.92	3.81
Nov. 28.....	3.00	1.03	1.15	1.30	1.50						3.81
Nov. 30.....	2.36	.99	1.12	1.23	1.39		1.35	1.09			3.00
Means.....	.99	1.10	1.24	1.42			1.36	1.12	.99	.91	
Departures.....	+.07	+.07	+.06	+.07			+.01	-.06	-.05	-.01	

BLUE HILL, MASS.

Nov. 1.....	6.1						0.94				5.1
Nov. 5.....	6.3						1.28	1.14	1.00	0.89	5.0
Nov. 6.....	3.8				1.31		1.37				3.5
Nov. 21.....	4.2		0.82	0.96	1.30		1.35	1.23	1.12	1.01	4.8
Nov. 22.....	3.5			1.06	1.29						3.3
Nov. 23.....	2.0	0.90	1.08	1.24	1.42		1.42	1.25	1.00	.89	2.1
Nov. 26.....	4.8			1.07							3.0
Nov. 27.....	2.0		1.00	1.09	1.34		1.34	1.22	1.07	.94	1.5
Nov. 28.....	1.6	.94	1.07	1.20							2.0
Nov. 30.....	1.8	.94	1.05	1.29	1.35		1.31	1.12	.88	.73	1.3
Means.....		.93	1.00	1.13	1.34		1.29	1.19	1.01	.89	

¹ Extrapolated.

TABLE 2.—Average daily totals of solar radiation (direct + diffuse) received on a horizontal surface

Week beginning—	Gram-calories per square centimeter															
	Wash- ington	Madison	Lincoln	Chicago	New York	Fresno	Fair- banks	Twin Falls	La Jolla	Miami	New Orleans	River- side	Blue Hill	San Juan	Friday Harbor	Ithaca
<i>1936</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>	<i>cal.</i>
Oct. 29.....	257	154	256	111	180	315	40	216	308	333	306	288	209	111	85	375
Nov. 5.....	204	191	265	159	179	316	28	210	350	309	188	323	215	146	215	425
Nov. 12.....	219	317	261	160	182	249	12	171	297	266	291	293	210	103	96	472
Nov. 19.....	176	145	228	120	143	279	11	168	278	300	230	245	166	120	120	442
Nov. 26.....	124	137	176	115	159	244	20	153	254	311	150	254	182	92	95	460
Departures from weekly normals																
Oct. 29.....	+11	-29	+18	-5	+6	-1	-1	-10	-----	+14	+40	-18	-21	-----	-27	-61
Nov. 5.....	-21	+27	+23	+33	+31	+9	-3	-2	-----	-35	-83	-4	+19	-----	+32	+89
Nov. 12.....	+23	+174	+54	+58	+55	+4	-14	+5	-----	-76	+50	-8	+31	-----	0	-14
Nov. 19.....	-13	+16	+22	+3	+17	+37	-8	+12	-----	-28	+9	-27	+4	-----	+27	+18
Nov. 26.....	-40	+13	-9	+29	+50	+23	+4	-3	-----	+26	-63	-8	+33	-----	+9	+5
Accumulated departures on—																
	+5,474	+3,976	+8,351	+11,242	+7,834	+5,096	-----	-2,690	-----	-8,561	-----	-859	-1,113	-----	+1,449	+1,176

TABLE 3.—Total, I_m , and screened, I_s , I_r , solar radiation intensity measurements, obtained during November 1936 and determinations of the atmospheric turbidity factor, β , and water-vapor content, m =depth in millimeters, if precipitated

AMERICAN UNIVERSITY, WASHINGTON, D. C.

Date and hour angle	Solar altitude	Air mass	I_m	I_s	I_r	β_{I_r-r}	Percentage of solar constant		w	Air-mass type
							$\frac{I_{w=0}}{1.94}$	$\frac{I_{w=0}-I_m}{1.94}$		
<i>1936</i>										
<i>Nov. 10</i>										
3:06 a. m.....	18 59	3.05	0.825	0.684	0.572	0.037	69.6	26.4	m	Np.
3:02 a. m.....	19 36	2.96	.833	.686	.574	.039	68.0	25.4	>50	
<i>Nov. 19</i>										
1:13 a. m.....	29 11	2.05	1.411	1.034	.832	.016	81.2	9.8	6.9	Pc.
1:18 a. m.....	28 51	2.07	1.386	1.030	.832	.019	80.5	9.8	6.8	
<i>Nov. 23</i>										
0:40 a. m.....	30 01	2.00	1.117	.865	.714	.086	66.3	9.3	5.4	Np.
0:32 a. m.....	30 16	1.98	1.126	.869	.710	.090	66.3	8.9	4.8	
<i>Nov. 27</i>										
2:40 a. m.....	19 13	3.02	.724	.556	.482	.164	43.0	6.1	1.7	Pc.
2:33 a. m.....	20 20	2.86	.709	.556	.482	.176	42.5	6.4	1.9	

* Corrected for mean solar distance.

Meteorological conditions during turbidity measurements

Nov. 10. Temperature 6° C.; wind, NW 14; polarization, 53.6 percent; visibility, 20 miles; blueness of sky, 5.
 Nov. 19. Temperature -5° C.; wind, S 9; polarization, 57.6 percent; visibility, 30 miles; blueness of sky, 5.
 Nov. 23. Temperature 2° C.; wind, NW 12; polarization, 52.8 percent; visibility, 12 miles; blueness of sky, 4.
 Nov. 27. Temperature -3° C.; wind, NW 14; polarization, 52.2 percent; visibility, 5 miles; blueness of sky, 4.

BLUE HILL OBSERVATORY OF HARVARD UNIVERSITY

Date and hour angle	Solar altitude	Air mass	I_m	I_s	I_r	$\frac{I_s}{0.851+c}$	$\frac{I_r}{0.840+c}$	β_{I_r-r}	$\frac{I_{w=0}}{1.94}$	$\frac{I_{w=0}-I_m}{1.94}$	w	Air-mass type
<i>1936</i>												
<i>Nov. 1</i>												
0:52 p. m.....	32 32	1.86	0.990	0.678	0.525	0.785	0.617	0.092	67.6	17.3	m	Nr→Tm.
<i>Nov. 5</i>												
3:53 p. m.....	11 49	4.79	.999	.667	.554	.768	.646	.089	55.0	7.8	3.9	Pc.
<i>Nov. 6</i>												
0:20 a. m.....	32 44	1.85	1.307	.871	.705	1.001	.818	.070	71.8	5.6	4.0	Pc.
0:30 p. m.....	32 44	1.85	1.366	.891	.707	1.025	.882	.045	76.1	6.9	4.9	
<i>Nov. 21</i>												
3:06 a. m.....	14 31	4.08	.644	.469	.409	.567	.473	.142	40.2	7.8	3.8	Npp.
0:08 a. m.....	27 57	2.13	.957	.660	.528	.754	.610	.111	60.2	12.1	8.2	
3:14 p. m.....	14 03	4.08	.556	.415	.348	.475	.403	.127	42.2	14.3	7.0	
<i>Nov. 22</i>												
2:31 a. m.....	18 37	3.11	1.126	.730	.607	.835	.703	.077	58.5	7.0	3.8	Pp+Pc.
<i>Nov. 23</i>												
3:14 a. m.....	13 40	4.16	1.055	.770	.677	.878	.781	.085	60.5	7.2	3.5	Pc.
2:12 a. m.....	20 19	2.86	1.268	.878	.720	1.000	.830	.045	69.0	5.7	3.3	
0:55 p. m.....	26 23	2.25	1.374	.927	.750	1.056	.864	.041	75.2	5.9	3.8	
3:14 p. m.....	12 40	4.16	1.071	.786	.647	.908	.747	.025	67.8	14.0	6.8	
<i>Nov. 26</i>												
1:50 p. m.....	21 56	2.66	1.100	.744	.632	.870	.741	.101	57.5	2.3	1.2	Pc.
<i>Nov. 27</i>												
3:14 a. m.....	12 30	4.54	.981	.693	.605	.786	.695	.075	51.0	1.8	.7	Pc.
0:17 a. m.....	26 36	2.22	1.331	.888	.730	1.007	.838	.071	67.9	1.1	.5	
1:39 p. m.....	22 33	2.60	1.282	.862	.716	.979	.823	.068	66.6	2.3	1.6	
3:56 p. m.....			.886	.553	.484	.628	.556					
<i>Nov. 28</i>												
3:14 a. m.....	12 18	4.61	.970	.699	.592	.793	.688	.060	53.2	12.1	5.5	Nrc.
<i>Nov. 30</i>												
3:55 a. m.....			.820	.665	.545	.755	.626					Pc.
0:21 a. m.....	26 51	2.21	1.337	.913	.745	1.036	.856	.055	71.0	3.9	2.4	
3:42 p. m.....	8 27		.521	.404	.360	.513	.413					

* Reduced to value at mean solar distance.

Atmospheric conditions during Smithsonian observations, November 1936

Date	Time from apparent noon	Temperature °C.	Wind, Beaufort	Visibility	Sky blue-ness	Cloudiness and remarks
Nov. 1	1:56 p. m.	+15.9	SW 4	8	7	Few Ci, 1 Acu, light haze, instr. indoors.
5	3:29 p. m.	+7.5	NNW 5	9	7	Few Ci, 1 Cu.
9	0:17 p. m.	+5.6	NW 2	9	7	1 Cu, light haze.
9	2:55 p. m.	+7.2	W 1	9	8	Few Ci, light haze.
10	2:21 p. m.	+7.3	W 1	9	8	Few Cu, light haze, instr. indoors.
11	1:17 a. m.	-0.2	WNW 4	9	8	Zero clouds, light haze, instr. indoors.
12	2:54 a. m.	+3.1	SW 4	6	7	1 Ci, moderate haze.
13	2:02 a. m.	+5.3	N 4	5	6	Zero clouds, dense haze.
14	2:33 a. m.	+3.6	S 5	6	7	Few Ci, dense haze, instr. indoors.
15	0:21 a. m.	+9.1	W 4	8	7	Few Cu, light haze.
18	1:35 a. m.	-6.7	NNW 7	9	7	Few Acu, light haze, instr. indoors.
19	1:00 a. m.	-6.8	NW 6	9	7	Do.
21	3:00 a. m.	-6.7	SW 3	6	7	Few Ci, 2 Acu, moderate haze.
21	3:17 p. m.	+14.2	W 4	7	7	Few Cu, Few Acu, moderate haze.
23	2:08 a. m.	-4.2	WNW 5	9	7	Few Cu, light haze, instr. indoors.
23	0:35 p. m.	-1.9	NW 5	9	8	Few Cu, light haze, instr. indoors.
26	1:50 p. m.	-0.8	WNW 5	8	7	Few Acu, few Cu, light haze, instr. indoors.
27	3:10 a. m.	-7.5	WSW 3	7	7	Few Ci, few Cu, light haze, instr. indoors.
27	1:43 p. m.	-4.6	W 4	8	7	Do.
28	3:00 a. m.	-8.8	S 3	7	7	Zero clouds, moderate haze.
30	3:51 a. m.	-7.7	W 4	5	7	Few Stcu, Freu, Cu, light haze.

POSITIONS AND AREAS OF SUN SPOTS

Note.—The report for December 1936, not having been received in time, will be included in the January 1937 issue of the REVIEW.—*Ed.*

PROVISIONAL SUN-SPOT RELATIVE NUMBERS, NOVEMBER 1936

[Dependent alone on observations at Zurich and its station at Arosa]

[Data furnished through the courtesy of Prof. W. Brunner, Eidgen, Sternwarte, Zurich, Switzerland]

November 1936	Relative numbers	November 1936	Relative numbers	November 1936	Relative numbers
1-----	d 118	11-----	Eac 148	21-----	28
2-----	a --	12-----	aa 133	22-----	b 39
3-----	Eac 149	13-----	a --	23-----	d 46
4-----	ad 140	14-----	ab --	24-----	43
5-----	159	15-----	119	25-----	Ecd 70
6-----	Eacd 151	16-----	95	26-----	96
7-----	ad 127	17-----	Ec 92	27-----	d 141
8-----	Ecd 140	18-----	61	28-----	Ec 212
9-----	127	19-----	60	29-----	ab 192
10-----	150	20-----	-----	30-----	-----

Mean, 25 days=113.4.

a= Passage of an average-sized group through the central meridian.
b= Passage of a large group or spot through the central meridian.
c= New formation of a group developing in a middle-sized or large center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, in the central circle zone.
d= Entrance of a large or average-sized center of activity on the east limb.

AEROLOGICAL OBSERVATIONS

[Aerological Division, D. M. LITTLE in charge]

By L. P. HARRISON

Mean free-air temperatures and relative humidities for November, as determined from airplane weather observations, are given in table 1. The "departures from normal" given in the table are based on "normals" derived from the number of observations indicated in the note at the foot of the table, where the number of years over which the observations were taken are given by the figures in parentheses. In general, the numbers of observations available for computing "normals" for the higher levels are less than those available for the lowest levels (represented by the data given in the footnote). To compensate for this discrepancy, the "normals" are obtained by applying the mean differences between the successive standard levels to the data for the lower levels, where the "normal" for the surface based on the indicated number of observations serves as the reference basis. The "normals" in each case include the data for the current month. It will be noted that many of the "normals" are based on only 3 years of observations. "Departures from normal" in such cases must be regarded as having little weight in comparison with departures from "normals" based on much more extended periods of record (35 or more years, say, which are not uncommon in climatology).

The mean temperatures for the month at the surface (see chart I) were generally below normal in the eastern half of the country, and in most of Texas and southern New Mexico, as well as in a large part of the extreme northwest portion of the country with the exception of northwestern Washington, which had above-normal temperatures. The largest negative departures from normal at the surface were to be found in the Great Lakes region and southward for several hundred miles, with an average of about -2°C ., and also in the northern half of the extreme northwest portion of the country (excepting northwest Washington) with an average of nearly -3°C . The re-

maining portion of the country and southwestern Canada largely had above-normal temperatures at the surface, with maximum positive departures to be found in the southern California coast region, and notably in southwestern Canada where the average departure from normal appeared to be slightly over $+4^{\circ}\text{C}$.

The mean temperatures for the month in the free air (see table 1) appeared to show that the significant negative departures from normal observed at the surface near and somewhat to the south of the Great Lakes region were not merely superficial but were also predominantly in evidence at all elevations up to at least 5 km in the northeast sector of the country, with perhaps the exception of the levels from 3 to 5 km near the coastal area adjacent to New York. (See Mitchel Field.) If we may regard the departures from normal given in table 1 as representative, the data for Selfridge Field (Mount Clemens, near Detroit), Mich., Wright Field (Dayton), Ohio, and Omaha, Nebr., indicate that departures from about -2° to -4°C ., prevailed in the area under consideration.

The mean temperatures for the month in the free air also gave evidence that the extreme northwest part of the country at all levels up to 5 km, except the lowest stratum near the ground, was dominated by positive departures from "normal temperatures" ranging from 0° to a maximum of $+4^{\circ}\text{C}$. This condition apparently was associated in some manner with the similar above-normal temperatures observed at the surface in southwestern Canada and northwestern Washington.

Mean free-air relative humidities for the month were slightly above normal in the extreme southwestern portion of the country at practically all levels up to 5 km, and also in the south-central portion at moderate and higher elevations (2.5 to 5 km). (Note departures: +5 percent to 8 percent at San Diego from 1.5 to 5 km; +7 to 11 per-